STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC HEALTH
DRINKING WATER OPERATOR CERTIFICATION PROGRAM

Units and Conversion Factors

1 cubic foot of water weighs 62.3832 lb
1 gallon of water weighs 8.34 lb
1 liter of water weighs 1,000 gm
1 mg/L = 1 part per million (ppm)
1% = 10,000 ppm
ft^2 = square feet and ft^3 = cubic feet
1 mile = 5,280 feet (ft)
1 yd^3 = 27ft^3 and 1 yard = 3 feet
1 acre (a) = 43,560 square feet (ft^2)
1 acre foot = 325,829 gallons
1 cubic foot (ft^3) = 7.48 gallons (gal)
1 gal = 3.785 liters (L)
1 L = 1,000 milliliters (ml)
1 pound (lb) = 454 grams (gm)
1 lb = 7,000 grains (gr)
1 grain per gallon (gpg) = 17.1 mg/L
1 gm = 1,000 milligrams (mg)
1 day = 24 hr = 1,440 min = 86,400 sec
1,000,000 gal/day ÷ 86,400 sec/day ÷ 7.48 gal/cu ft = 1.55 cu ft/sec/MGD

CHLORINATION

Dosage, mg/l = (Demand, mg/l) + (Residual, mg/l)

(Gas) lbs = Vol, MG x ppm or mg/L x 8.34 lbs/gal

HTH Solid (lbs) =
$$\frac{\text{(Vol, MG) x (ppm or mg/L) x 8.34 lbs/gal}}{\text{(\% Strength / 100)}}$$

Liquid (gal) =
$$\frac{\text{(Vol, MG) x (ppm or mg/L) x 8.34 lbs/gal}}{\text{(\% Strength /100) x Chemical Wt. (lbs/gal)}}$$

PRESSURE

PSI = $\frac{\text{(Head, ft.)}}{\text{2.31ft./psi}}$ **PSI** = Head, ft. x 0.433 PSI/ft.

lbs Force = (0.785) (D, ft.)^2 x 144 in^2/ft^2 x PSI.

VOLUME

Rectangular Basin Volume, gal =
(Length, ft) x (Width, ft) x (Height, ft) x7.48 gal/cu.ft.

Cylinder , Volume, gal =
(0.785) x (Dia, ft)^2 x (Height, Depth, or Length in ft.) x 7.48 gal/ft^3

Time, Hrs. =
$$\frac{\text{Volume, gallons}}{\text{(Pumping Rate, GPM, x 60 Min/Hr)}}$$

Supply, Hrs. =
$$\frac{\text{Storage Volume, Gals}}{\text{(Flow In, GPM – Flow Out, GPM) x 60 min/hr.)}}$$

SOLUTIONS

Lbs/Gal = $\frac{\text{(Solution \%)}}{100}$ x 8. 34 lbs/gal x Specific Gravity

Lbs Chemical =
Specific Gravity x 8.34 lbs/gallons x Solution(gal)

Specific Gravity = $\frac{\text{Chemical Wt. (lbs/gal)}}{\text{8. 34 (lbs/gal)}}$

% of Chemical in Solution =
$$\frac{\text{(Dry Chemical, Lbs) x 100}}{\text{(Dry Wt. Chemical, Lbs) + (Water, Lbs)}}$$

GPD =
$$\frac{\text{(MGD) x (ppm or mg/L) x 8.34 lbs/gal}}{\text{(\% purity) x Chemical Wt. (lbs/gal)}}$$

GPD =
$$\frac{\text{(Feed, ml/min. x 1,440 min/day)}}{\text{(1,000 ml/L x 3.785 L/Gal)}}$$

Two – Normal Equations:

a) $C_1V_1 = C_2V_2$ $\frac{Q_1}{V_1} = \frac{Q_2}{V_2}$

b) $C_1V_1 + C_2V_2 = C_3V_3$

C = Concentration, V = Volume, Q = Flow

PUMPING

1 horsepower (Hp) = 746 watts = 0.746 kw = 3,960 gal/min/ft

Water Hp = $\frac{\text{(GPM) x (Total Head, ft)}}{\text{(3,960 gal/min/ft)}}$

Brake Hp = $\frac{\text{(GPM) x (Total Head, ft)}}{\text{(3,960) x (Pump \% Efficiency)}}$

Motor Hp = $\frac{\text{(GPM) x (Total Head, ft)}}{\text{(3,960) x Pump \% Eff. x Motor \% Eff.}}$

"Wire to Water" Efficiency
= (Motor, % Efficiency x Pump % Efficiency)

Cost, $ =
(Hp) x (0.746 Kw/Hp) x (Operating Hrs.) x cents/Kw-Hr

Flow, velocity, area

Q = A x V   Quantity = Area x Velocity

Flow (ft^3/sec) = Area(ft^2) x Velocity (ft/sec)

$$\frac{\text{MGD x 1.55 cu ft/sec/MGD}}{\text{.785 x pipe diameter ft x pipe diameter ft}} = \frac{\text{cu ft/sec}}{\text{sq ft}} = \text{ft/sec}$$

General

($) Cost / day = Lbs/day x ($) Cost/lb

Removal, Percent = $\frac{\text{(In - Out)}}{\text{In}}$ x 100

Specific Capacity, GPM/ft. = $\frac{\text{Well Yield, GPM}}{\text{Drawdown, ft.}}$

Gals/Day = (Population) x (Gals/Capita/Day)

GPD = $\frac{\text{(Meter Read 2 - Meter Read 1)}}{\text{(Number of Days)}}$

Volume, Gals = GPM x Time, minutes

SCADA = 4 mA to 20 mA analog signal

$$\frac{\text{(live signal mA - 4 mA off set) x process unit and range}}{\text{(16 mA span)}}$$

4 mA = 0   20 mA full -range

FILTRATION

Filtration Rate (GPM/sq.ft) = $\frac{\text{Filter Production (gallons per day)}}{\text{(Filter area sq. ft.) x (1,440 min/day)}}$ sq. ft. = square feet

Loading Rate (GPM/ sq. ft.) = $\frac{\text{(Flow Rate, GPM)}}{\text{(Filter Area, sq. ft.)}}$

Daily Filter Production (GPD) = (Filter Area, sq. ft.) x (GPM/ sq. ft. x 1,440 min/day)

Backwash Pumping Rate (GPM) = (Filter Area, sq. ft.) x (Backwash Rate, GPM/ sq. ft.)

Backwash Volume (Gallons) = (Filter Area, sq. ft.) x (Backwash Rate, gpm/ sq. ft.) x (Time, min).

Backwash Rate, GPM/ sq. ft. = $\frac{\text{(Backwash Volume, gallons)}}{\text{(Filter Area, sq. ft.) x (Time, min)}}$

Rate of Rise (inches per min.) = $\frac{\text{(backwash rate gpm/sq.ft.) x 12 inches /ft}}{\text{7.48 gal/cu.ft.}}$

Unit Filter Run Volume, (UFRV) = $\frac{\text{(gallons produced in a filter run)}}{\text{(filter area sq. ft.)}}$

C• T CALCULATIONS

C• t = (Chlorine Residual, mg/L)x(Time, minutes)

Time, minutes = $\frac{\text{(C• t)}}{\text{(Chlorine Residual, mg/L)}}$

Chlorine Residual (mg/L) = $\frac{\text{(C• t)}}{\text{(Time, minutes)}}$

Inactivation Ratio = $\frac{\text{(Actual System C• t)}}{\text{(Table “E” C• t)}}$

C• t Calculated = T_{10} Value, minutes x Chlorine Residual, mg/L

Log Removal = 1.0 - $\frac{\text{\% Removal}}{100}$ x Log key x (-1)

SEDIMENTATION

Surface Loading Rate, (GPD/ sq. ft.) = $\frac{\text{(Total Flow, GPD)}}{\text{(Surface Area, sq.ft.)}}$

Detention Time = $\frac{\text{Volume}}{\text{flow}}$

Detention Time hours = $\frac{\text{volume (cu ft) x 7.48 gal/cu ft x 24 hr/day}}{\text{Gal/day}}$

Flow Rate = $\frac{\text{Volume}}{\text{Time}}$

Weir Overflow Rate, GPD/L.F. = $\frac{\text{(Flow, GPD)}}{\text{(Weir length, ft.)}}$

Chemical Dosage Calculations

Note (% purity) and (% commercial purity) used in decimal form

Lbs/day gas feed dry = MGD x (ppm or mg/L) x 8.34 lbs/gal

Lbs/day = $\frac{\text{MGD x (ppm or mg/L) x 8.34 lbs/gal}}{\text{\% purity}}$

GPD = $\frac{\text{MGD x (ppm or mg/L) x 8.34 lbs/gal}}{\text{(\% purity) x lbs/gal}}$

GPD = $\frac{\text{MGD x (ppm or mg/L) x 8.34 lbs/gal}}{\text{(commercial purity \%) x (ion purity \%) x (lbs/gal)}}$

ppm or mg/l = $\frac{\text{lbs/day}}{\text{MGD x 8.34 lbs/gal}}$ or $\frac{\text{gallons x \% purity x lbs/gal}}{\text{MG x 8.34 lbs/gal}}$